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A Survey of Possible Sea Routes Available to the Tasmanian Aborigines

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Winds and Currents Ignored in many Anthropological Theories of Migration

In the past many anthropological theories have ignored the effects of wind and current and have postulated purposeful waves of migration in the teeth of both. In more recent years the importance of drifters, vagrants, accidental castaways and single canoes is being recognised.

Heyerdahl and five other Scandinavians in a 45 feet long reproduction of a Peruvian sailing-balsa, duplicated the conditions of a prehistoric raft 'trapped by the constant off-shore wind and the Humboldt Current' and making a subsequent helpless voyage in a great semi-circular arc on the South Equatorial Current (1947, p. 15). Not only were the theories of its impossibility proved wrong but the voyage was made to look easy, the 4300 miles to Raroia Atoll being covered in 101 days. Furthermore, on three occasions—once when Watzinger fell overboard, once in passing Pukapuka and once when passing Angatau—it proved impossible to deviate from the path dictated by wind and current.

Harrisson (1937, pp. 334-338) points out that wind and current support New Hebridean native mythology and known history in bringing new influences largely from the east. The New Hebrideans are the least nautical of Pacific islanders and possess the crudest canoes in the ocean. Yet commonly accepted theory takes Melanesian migration from the Solomons to the New Hebrides in the face of 'overwhelming strength and persistence of winds . . . including the south-east trades throughout the year'. Only in the first quarter of the year are there any north-west winds, those associated with the north-west monsoon and the hurricane season; only then is the 25 knots a day current drift setting to the north fairly negative. Harrisson estimates it would be necessary to paddle night and day to negative the drift, or with sail it would be necessary to run south-east and then south-west for 600 miles, and that with no landmarks. A voyage in a great circle east towards Polynesia, then south-west to Fiji and then east on wind and current into the New Hebrides, would be easier though much longer.

In 1918 two boys drifted 1300 miles from the Gilberts to the Carolines in 90 days, subsisting on rain water, six birds and one shark. Dixon says only one west to east drift has ever been recorded in Polynesia. Bligh, in his open boat

voyage of 49 days over 3600 miles from Tahiti to Timor in 1789, sighted and named the Banks Group. He was therefore sailing in a position where full current and wind assistance were being received.

Malinowski (1932, p. 222) says 'The main dangers of native . . . sailing . . . lie in the helplessness of a canoe'. 'Sailing has to be done in straight lines across the sea.' The canoe 'cannot sail close to the wind and therefore cannot beat'. 'The wind must strike the canoe on its outrigger side.' If the wind changes round, the canoe must also turn round and retrace its course. The Trobriand canoe is built so that bow and stern are reversible; if the wind drops the canoe may be at the mercy of three to five knot tides. The complex Kula voyages are performed with full observance of the prevailing winds in the two main seasons, and the between seasons of variable winds. Malinowski instances a Dobuan canoe caught in May 1918 by a strong south-easter, given up for lost and returning on a freak north-west blow in August. Usually the South-East Trade blows from May to October without veering and for a canoe caught in it there is no return, at least in that season.

In 1896, Harbo and Samuelson, two Norwegians, in a double ended boat 18 feet long by 5 feet beam and drawing only 8 inches when loaded, rowed 3250 miles across the Atlantic from New York to France; no sail was carried. Their course was via the Gulf Stream and the North Atlantic Drift, the current aiding them about a mile an hour. They started 6th June and arrived 7th August, averaging 51·6 miles a day.

R. and C. Berndt have dissected from the legends of the natives of Arnhem Land a series of contacts and migrations. These appear to be: (1) late Macassan 1780? to 1907; (2) an infusion of ideas concerning 'Badu' from Torres Strait and the south coast of New Guinea prior to 1780?; (3) early Macassan contact 1500? to 1780?; (4) Baijini people of historical but Pre-Macassan period, described as golden brown, arriving in boats and bringing rice, possibly from some part of Indonesia; (5) before these again Ancestral Beings in three groups—Kunapipi, Djanggewul, Laintjung—all from somewhere to the east.

It is significant that the Macassans came and went invariably on the prevailing monsoonal winds, so that their yearly arrival and departure were scheduled. The others are from the east, the path later taken by Torres, against which Tasman, attempting to go in the opposite direction, could make no headway. Myths and stories of Arnhem Land refer to drifting canoes and boats, with or without people, over a long period. The Berndts regard the islands of Torres Strait to the east as significant in this regard. I am indebted to Mr. and Mrs. Berndt for their permission to use this personal communication of material as yet unpublished.

Edgell (1948, p. 1) points out that 'All early voyages of any length must have been largely exploratory and dependent on a fair wind, for it was not until about the middle of the 17th century that ships began to beat to windward and so overcome a handicap hitherto imposed on their movements by the elements'. In the late days of European sail courses were plotted in terms of prevailing wind and current, not of the shortest distance between two points. In voyages from England to Australia via the Cape, the ship was taken far south to pick up the prevailing westerlies or 'roaring forties'.

These examples quoted cover the Atlantic, Pacific and Indonesian regions and a wide variety of craft. Heyerdahl's maximum speed with a sail-raft was 72 miles a day; the slowest journey, that of a drifting canoe, averaged 14 miles a day. The examples can be multiplied manyfold, and wind and current are almost invariably the major factors.

Analysis of Admiralty Charts

A close study of Admiralty Charts might be expected to throw some light on the Tasmanian problem.

Geradus Mercator produced the first chart on which meridians and parallels were drawn at right angles and measurable in sea miles; it was first used in 1569. Prior to John Harrison's marine chronometer (1760), the amount of easting or westing made good was dependent on dead reckoning, and little or no information was available about ocean currents (Edgell, 1948, p. 3). Strzelecki (1845, pp. 10, 11) referred to the deficiencies of charts prior to 1797; 'the obstinate secrecy of Portugese, Spaniards, and Dutch' resulted in maps showing the Australian land mass divided into east and west continents by a Carpentarian-Bight channel. Further, as late as 1745, Furneaux reported no strait but only a deep bay between New Holland and Van Diemen's Land.

Strzelecki made a personal study of the prevailing winds of New South Wales and Van Diemen's Land. Four plates illustrating his observations appear in his book. More significantly to our problem he refers (p. 170) to the conflict of two antagonistic winds: ascending the 2550 feet peak of Flinders' Island he observed a westerly wind on the west side of the peak and a north-easter on the east side. Ships entering the strait on an easterly breeze made Port Dalrymple on a westerly (p. 171).

Dannevig (1915) pointed out that the Southern Ocean Current pushes against Tasmania, King Island and Victoria, and although diverted before reaching land, a general drift through the Strait from west to east is established. The dominant westerlies, which accentuate the ocean current, also prevail in Bass Strait to the extent of 1·82 miles per hour or 16,000 miles per annum. The flood tides assume a north-easterly direction on passing King Island from the west, north and south, the main body being towards the centre of the Strait and a northern branch passing Cape Otway towards Port Phillip.

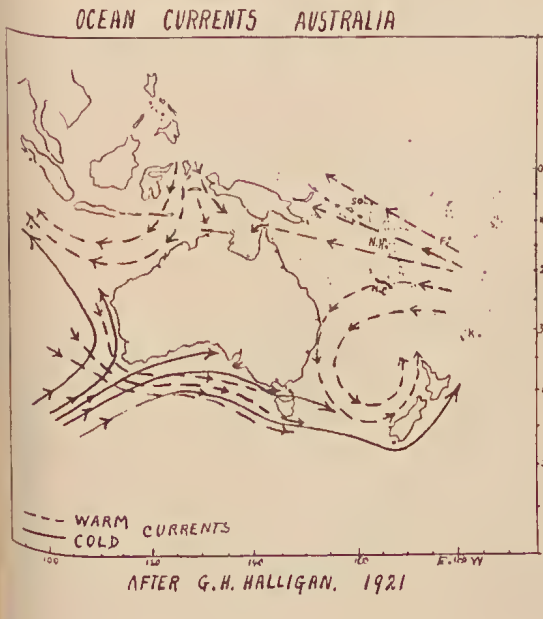


Fig. 1a

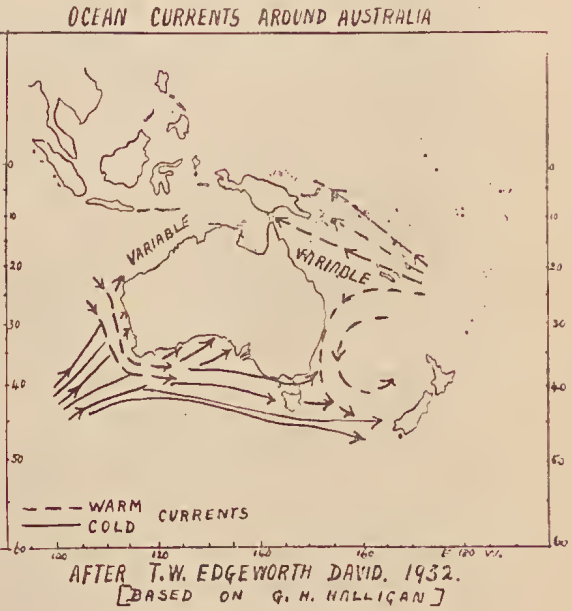


Fig. 1b

Halligan (1921) produced a chart of the ocean currents round Australia (Fig. 1*a*). The salient features concerning us are:—

(1) An indrift of warm light water from the Indian Ocean in a south-west direction meets a cold heavy indrift from the Antarctic Ocean in a north-east direction and produces a compounded southern branch which goes east across the Bight at 3 to 4 knots. Striking the Tasmanian Plateau there is partial obstruction and deflection.

(2) A branch of the South Equatorial Current is deflected towards the Queensland Coast. It is again deflected south into the Eastern Australian Current, 350 miles wide and with a velocity of 1½ knots at the littoral and 2 knots in the offing at all times and seasons as far as Jarvis Bay.

(3) From here onward its direction and velocity are variable, depending on interference by the Southern Ocean Current flowing east through Bass Strait and also by the effects of south-east and south-west winds. In the main it is deflected to the south-east, one branch striking New Zealand being deflected first north and then west into the Tasman Sea.

(4) To the north of Australia the remainder of the equatorial drift flows towards Cape York and into the Arafura Sea.

(5) The Arafura Sea Current sets westward in the south-east monsoon season (April-October) and eastward in the north-west monsoon.

In 1928 Halligan produced four charts giving the history of 157 bottles thrown overboard between 1890 and 1919, illustrating 'the extraordinary course bottles may take when delivered to the mercy of the winds, waves and currents' (p. 43).

David (1932, pp. 7-12) acknowledged and slightly modified Halligan's chart (Fig. 1*b*). He stressed: (1) that the Solomons and New Guinea rise directly in the path of the Trade Winds, and the Tasmanian west coast directly in the path of the westerly winds (p. 7); (2) that Australia is under the influence of the South-East Trade and the north-west monsoon; (3) that the south coast of Australia is dominated by westerly winds and current, the latter setting from west to east across the Bight and a small branch of it passing thence through Bass Strait (p. 10).

Ingleton (1944, p. viii) refers to the fact that 'the majority of Australian surveys were made many years ago' and 'the urgency for new surveys is almost daily emphasised . . . '; again (p. 87) ' . . . the coastline of Tasmania remains to this day very imperfectly examined, a condition of which Tasmanian shipping men are very well aware . . . '.

Keble (1946, p. 83) claims 'that the directions of the current and prevailing wind now found in Bass Strait persisted throughout the Pleistocene . . . '. The writer's own studies at the present stage do not permit him personally to affirm or modify this statement. Attention must therefore be drawn to the fact that for the purposes of this paper Keble's statement has been accepted as it stands.

Admiralty Map 1695B Bass Strait Western Sheet carries the comment: 'Currents—A current averaging from ½ to 1½ knots will generally be found setting through Bass St.; with & after Westly. winds it sets to the Eastd.; with & after Easterly winds to the westward. As Westerly and South Westerly Winds are the prevailing ones throughout the Strait the current will generally be found setting to the East and North East; its strength depending on the previous force of the wind.'. On the other hand another comment says: 'Tidal Stream—At the Eastern part of the fairway of Bass Strait, the flood stream comes from the Eastward

in a direct line from the Furneaux Group towards Hunter and King Islands. At these islands this tide is met by a flood stream coming from the south-westward:— the high tide thus made by the junction of the two streams occurs near King Island 2 hours after it is high water at the Furneaux Group. Vessels proceeding Eastward from the neighbourhood of King Island will find the tidal stream against them of longer duration than the stream in their favour.'.

Shipwrecks round the Australian coast provide some evidence. The data (Wrecks . . ., 1926) show that in the Bass Strait region the majority have occurred on the west side of King Island and on both sides of the Bassian chain. The southern Victorian coast comes next, and the northern coast of Tasmania has had least. Two wrecks of historical interest might be quoted. The schooner *Brothers*, formerly the property of Kelly, the famous sealer, was wrecked on the Kent Group in 1816 (Crowther, 1937). The emigrant ship *Cataraqui* was wrecked on a reef west of King Island in 1845 with a survivor list of nine, and finally caused the first lighthouse in Bass Strait to be erected at Cape Otway in 1848.

FIG. 2

PREVAILING WINDS IN QUARTERS.

Fig. 3a

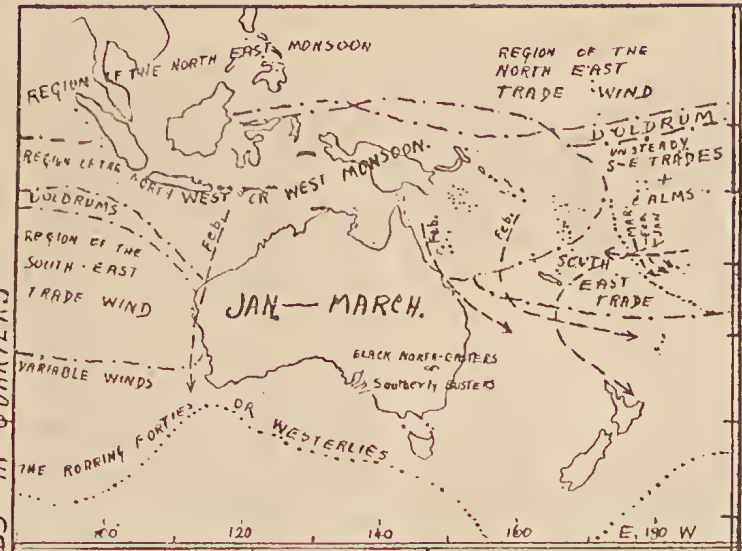


Fig. 3b

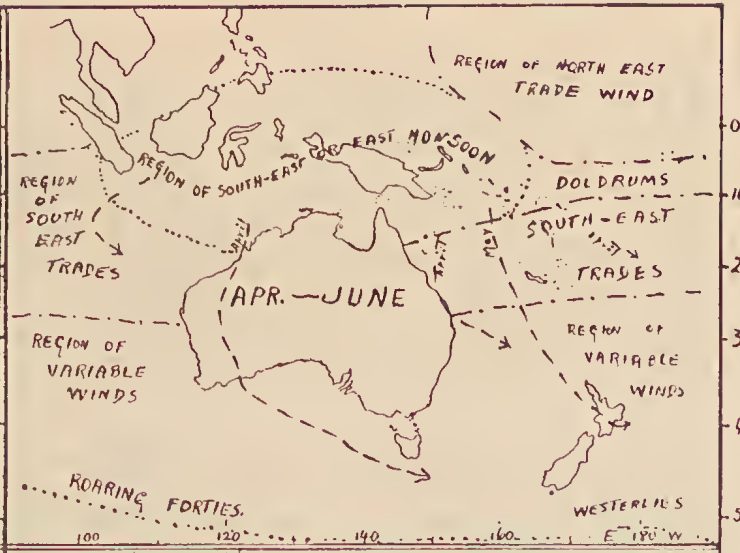
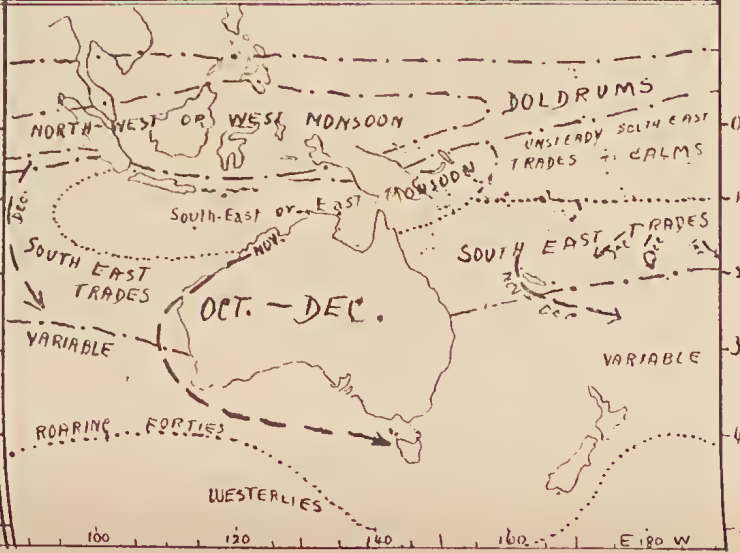


Fig. 3c

Fig. 3d



This is at variance with statements by Wunderly (1938*a*, p. 124). He endeavours to interpret James (1925, p. 137) to the effect that native craft could be blown to Tasmania from Otway or the east end of Victoria in two or three days and mentions boats and wreckage blown from Australia.

Admiralty wind charts provide information in two forms.

A. Monthly charts are set out in wind roses which give the average winds observed in each 5° square. 'The arrows fly with the winds grouped in direction to the nearest cardinal or quadrantal point; their length gives percentage frequency measured from the centre of the circle by scale. When the full length cannot be shown the line is broken and the percentage shown by figures. The number of feathers on the arrows indicates the average force of the wind by Beaufort scale. The figure in the centre of the rose indicates the percentage of gales (Beaufort Force 8 and above) from all directions; where no figure is given, data is insufficient. Five per cent frequency or less is not shown in the wind roses.' Fig. 2 is given as an illustration; it has been made from the Admiralty chart for January. We observe that in the Bass Strait region the arrows indicate a predominance of west and south-west wind. Throughout the year these conditions hold. A hot north-west wind does occasionally appear. Neither in force nor in persistence would it appear to be adequate to carry a craft from the Victorian to the Tasmanian coast prior to the re-establishment of prevailing conditions. Other regions that may concern our problem present a preponderance of easterly arrows between Melanesia and the New Guinea-Queensland region. Further south the arrows are more variable; north-east arrows come into the picture well east of Gabo, but no westerly prominence appears in this part of the Pacific until a fair distance south-east of Tasmania.

B. The monthly charts are coalesced into prevailing oceanic winds for each quarter of the year. On these the 'Probable Tracks of Cyclones' are shown also. Diagrams (Figs. 3*a*, 3*b*, 3*c*, 3*d*) have been adapted from these as illustration. These quarterly charts confirm all the examples quoted at the beginning of the paper.

In the New Hebridean region the South-East Trades are constant through the year, save for January-March, when the north-west or west monsoonal fringe involves them. The Trobriands are under monsoon influence for the entire year, and the South-East Trades also for July-September. The north and north-west region of Australia is subjected to monsoons and Trades which also involve the region of the Celebes and the Indonesian chain of islands. The southern half of the eastern coast of Australia is in the variable wind belt. Well south of Australia and Tasmania, the westerlies are completely dominant.

From the cyclonic aspect, January-March are bad times to be at sea between Melanesia and Queensland; April-June are not much better. July-September offer hazards between the Australian and New Zealand coasts. As a contrast, October-December offer all clear sailing off the east coast of Australia.

South Pacific Ocean Currents offers charts for each quarter of the year, in the form of: (*a*) Current Roses, (*b*) Resultant Current Arrows, compiled from observations of set and drift observed between 1910 and 1937. These charts, unlike older charts, give mean strength of current and percentage frequency of drifts of various strengths. They specifically state that the 'Roses and Diagrams show that ocean currents are very variable'.

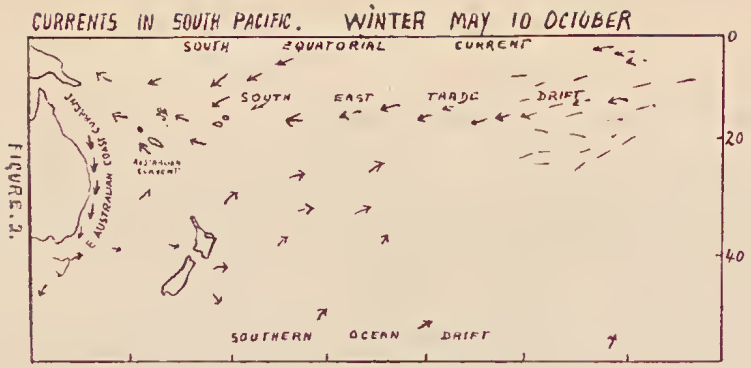


FIG. 4a

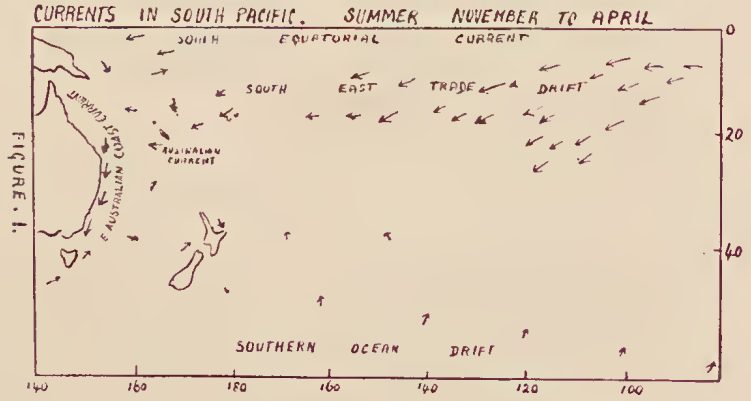


FIG. 4b

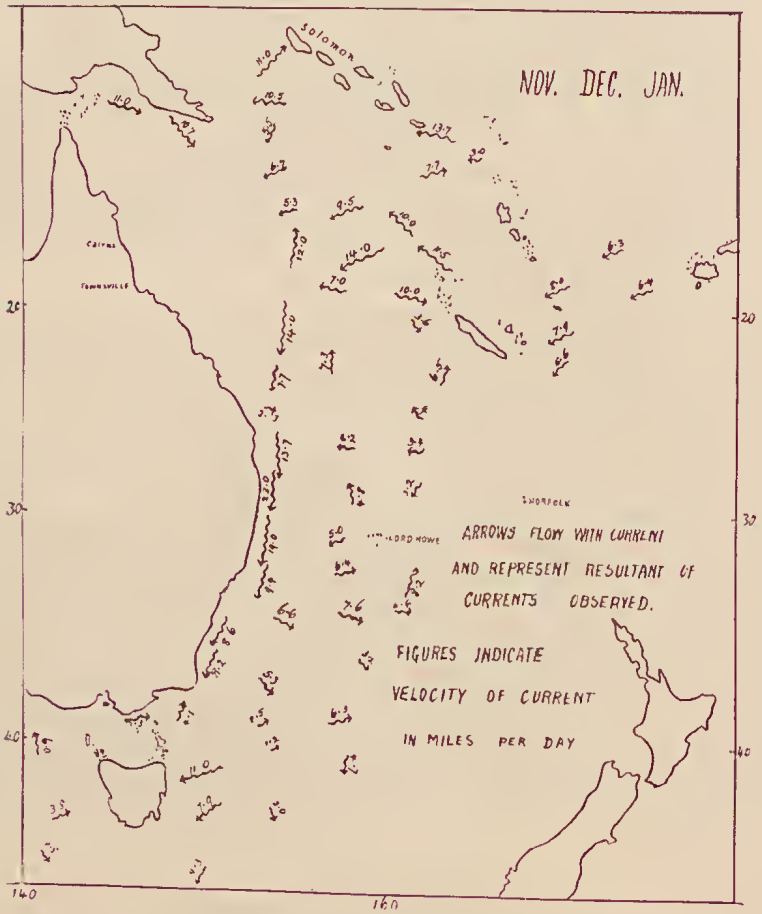


FIG. 5

Diagrams have been prepared from these charts. Figs. 4*a*, 4*b* show the general circulation of the ocean. Arrows of different length and thickness denote the relative strength of currents. Apart from a few minor variations the circulation is the same throughout the year, though subject to seasonal variations of set and drift. Quoting, 'the main 4 currents are:—(1) South Equatorial Current, between the Equator and Lat. 6° S and its weaker extension, the S.E. Trade Drift, between Lat. 6° S and 20° S, setting westward right across the ocean. (2) East Australian Coast Current, setting south from the Coral Sea down the coasts of Queensland and N.S.W. (3) Southern Ocean Drift, setting in directions between North and East in Southern Latitudes, which has only a weak mean drift—the result of currents, seldom exceeding 1 knot of variable set. (4) Peru or Humboldt Current, setting North up coasts of Peru and Chile.'

The greatest drifts in relation to Australasia are 3 knots in the South Equatorial Current west of longitude 124° W. and 4 knots in the East Australian Coast Current in Lat. 28° S. to 30° S. The East Australian Coast Current is weakest during the southern winter; the reverse sets are much stronger than in the South Equatorial Current. Sets off shore and on shore may also occur. Between New South Wales and New Zealand easterly sets predominate. Between New Caledonia and New Zealand northerly sets predominate. South of New Caledonia there is a weak westerly set, i.e., the Australian or New Holland Current towards the Australian Coast.

Fig. 5 shows Resultant Current Arrows in east Australian waters for November, December, and January. It is seen that no observations are available for the New Hebridean region. To the west of the New Hebrides the current flows north-west at 11·5 miles per day; further west the current flows south-west at 14 miles per day, coming into the region of the East Australian Coast Current flowing south at varying rates but in one place as high as 23 miles per day. From the region of Gabo there is a swing to the south-east of between 5 and 6 miles per day, then a limited region of weak velocity currents in various directions. A little further south at about Lat. 40° S, a current of 11 miles a day flows west-south-west to the east coast of Tasmania.

Personal Experience

My interest in this subject first occurred about 14 years ago on observing native one-man fishing craft out of sight of land in the Java Sea. It was renewed about 9 years ago when I became aware of the discrepancy between distance steamed by engines and distance covered over the ground. If winds and currents could so affect a steamer, what effect would they have on native craft? It seemed possible that observations over a two-year period might throw some light on the problem.

In 20 months extending from March of one year to November of the following year, out of 619 days the total spent in actual steaming was 405 days. In this time 59,680 miles were steamed by engines and 41,575 miles covered over the ground, or a shade over 4 knots day and night by engines but only 3 over the ground. During this same time intermittent periods totalling 140 days were spent in Bass Strait, where 10,000 miles were covered at an average of 3 miles per hour over the ground, day and night steaming (Plate XIII A); in other words, at the same average speed accomplished by Bligh in his open boat voyage, and an average about twice as fast as that of a primitive native craft.

It is a common statement that Bass Strait is one of the most storm lashed and violent waterways of the world. Of the 140 days spent there only 28 presented conditions of storm, squall or seas sufficiently violent to make survival of frail native craft unlikely. The remaining 112 on the contrary were days of perfect

weather, clear skies and the sea almost as smooth as a pond. Of the 28 bad weather days 23 were off Cape Otway or between Cape Otway and King Island (out of a total of 38 days which were spent in that vicinity); 3 more of the bad weather days were at Sealer's Cove; and the remaining 2 occurred off the entrance to Port Phillip. The bad weather and tremendous seas at Cape Otway occurred in June, November and December of the first year, May and August of the second year. At Port Phillip entrance the bad weather occurred in June of the first year; and at Sealers' Cove in December of the first year and January and July of the second year. In other words the 28 bad weather days were widely spread over 20 months and not confined to any one period of the year.

Aerial and aquatic population in the Strait was more than abundant. On one occasion for an entire four days in placid conditions dolphins in hundreds were breaking the sea surface.

Mountain peaks at Wilson Promontory were climbed whenever landings were made and the range of visibility from the various elevations was observed.

The following possibilities arise out of the data considered. (Reference to Figs *3a*, *3b*, *3c*, *3d* will enable the discussion to be visualised.)

North-west corner of Australia.—Under the influence of prevailing currents and winds, aboriginal contacts or migrations are not only possible but extremely likely from January to March, the departure places being anywhere between Celebes, Timor and Flores. It would appear from the charts that India does not enter into the problem at all. To the same region, to the eastern side of Arnhem Land and to the shores of Carpentaria, contact or migration is very likely from the east, particularly in the months of July to December; the immediate departure places could be the islands of Torres Strait, New Guinea, or the northern groups of the Melanesian chain.

West coast of Australia.—Contact is extremely unlikely. On the contrary, canoes going adrift from the west coast are more likely to be carried into and across the Indian Ocean in a north-westerly direction.

South-west corner of Australia.—No contact is likely except in the form of wreckage carried by November cyclones from the north-west corner round the west coast into the Bight and ultimately to the west corner of Tasmania.

Southern coast of Australia.—Both current and wind would favour a voyage with point of departure in the south-west corner of Australia and arrival anywhere along the southern coast of Australia, the west coasts of King Island, Tasmania or the Bassian islands; but the arrival would probably be in the form of wreckage. The objection to a successful voyage is that the regions off the Leuwin, off Otway and in the Bight itself show a preponderance of violent winds and heavy seas, as experienced personally on many occasions over a number of years.

Malinowski (1932, p. 226) points out that the native craft is 'very light, very shallow', has 'very little water board' and 'easily fills in storm and in rain'. 'In rough weather a waterlogged canoe loses its buoyancy and gets broken up'. The evidence of Malinowski and Harrisson and of the examples quoted at the beginning of this paper indicate that the problem is not of food and water, not of distance and time, but rather of (1) storms and heavy seas, (2) human inability to paddle or sail continuously against ocean currents and winds.

The few individual variants claimed by Wunderly (1938*a*) as Australians among the west coast tribe of Tasmanian aborigines might just possibly represent a survival from such a chance voyage; but the data suggest the possibility is so remote as to be almost negligible.

The Western Pacific Region related to the Shores of Australia and Tasmania

(See Fig. 5)

The possibility does exist of a raft or canoe being caught up in November by wind and current west of the New Hebrides, carried some distance north-west, then some distance south-west, then south on the East Australian Current. Opposite Gabo it would be swung to the south-east and a subsequent south-westerly swing would bring it to the east coast of Tasmania. Prevailing easterly winds up the Derwent in December could finish the voyage in good order. The total distance would be about 2600 miles. At an average speed of 1·5 miles an hour, the voyage would last from 70 to 75 days. At 2 miles an hour the voyage would last about 54 days.

The second possibility is a landing on the Australian east coast and continuing the journey in stages. This is not so likely, as the East Australian Coast Current is 350 miles wide, the velocity in the offing is greater than the inshore velocity and it seems likely that any landing would be well down the Queensland or even New South Wales coast.

It is worth observing that the famous Captain J. Illingworth in the yacht *Rani* in the 1945-46 Sydney-Hobart yacht race adopted precisely the same course as the southern portion of the voyage postulated here. He went right out of sight of land, obtained the maximum current velocity, swung south-east, then south-west, approached Hobart directly from the east, and won the race from a field which believed him lost at sea. Curiously, this has not affected the general subsequent procedure, the yachts remaining inshore, meeting reverse sets and losing the main current velocity. I do not press the circumstances here laid out, but they once again illustrate the fact that the arc of a circle, under wind and current influence, is longer but faster than the direct route, which may be actually impossible.

Some of Meston's (1937, pp. 88-9) statements are correct. A native craft would almost certainly find a direct route of 1700 miles in a straight line from New Caledonia to Tasmania impossible. Meston describes the voyage as 'against a constant wind and high sea'. The high sea does not necessarily hold and it is not strictly a case of against the wind, but rather across the wind; it is, however, against a northerly current set which Meston does not mention. To speak of the survival of blown-away natives in an open boat, under a blazing sun and short of food and water as 'so wildly improbable and fantastic as to be regarded as impossible', as Meston does, is to overlook completely examples quoted in this paper. Meston himself (1936) quotes examples of extraordinary feats by native craft and still more desperate situations which have been survived. Ingleton (1944) refers to three airmen compelled to embark in a rubber boat without food or water, sail or oars, capsized by hurricanes and still arriving on an island after 34 days. In more detail, they traversed 1000 miles of sea and lived on rain water and the two fish, one albatross, one shark with two herrings inside it, one tern and two coconuts which they managed to obtain (Trumbull, 1943).

Wunderly (1938*b*, p. 200) accepts Meston's opinion without further investigation and uses it to refute the views of Wood Jones. In this particular Wunderly's argument should be discounted because Wood Jones on no occasion specified an actual plotted sea route. The words employed by Wood Jones (1935, pp. 5, 7) are: (1) 'precarious sea passage', (2) 'from their presumed home in some of the Melanesian islands far to the North and East', and (3) 'It matters but little if they found his nearest relatives in New Caledonia, New Ireland, the Andamans, . . .'.

From the charts of winds and currents the New Hebrides would seem a more likely contact with Australia than would New Caledonia. Both are in the path of the South-East Trades, but, in addition, to the west of the New Hebrides there are currents setting more or less west. New Caledonia is well south of these and also is well north of the westerly setting New Holland Current.

When hydrographers, surveyors, navigators and engineers were first approached by the writer as to the possibility of a native craft voyaging from the New Hebrides to Tasmania they unanimously said it would be impossible; but after presenting to them the route and the data above they agreed that it was a possibility. They subsequently became so interested as to review all the circumstances and commend the entire idea as a definite possibility.

It must be pointed out, however, that all were doubtful of what could happen to the east of Tasmania in the small local region of negligible currents after the swing to the south-east from Gabo. They themselves provided information that the occasional south-easters and south-westers that are experienced from New Zealand could bridge the local area and carry the craft into its final south-west current. Also they pointed out that the natives would have to sit in their craft for a very long time. When reminded of the velocities of currents and winds as laid down in the charts for this semi-circular arc, they became even less conservative than the writer.

A third objection raised by all of them was that New Hebridean craft were of exceptionally poor type, Tasmanian craft barely existed and such craft or even better craft would probably not survive such a voyage. The subject of native craft and this last objection have already been touched on and further references to the investigations of Roth (1899, pp. 154-159), Bonwick (1878*b*, pp. 52-53), Deacon (1934, p. 211), Pearson (1939, pp. 221-225), Harrisson (1937, p. 103), Meston (1936, pp. 155-162), and particularly Hornell (1946, pp. 1, 3, 4, 39-54, 60, 81-82, 182-3, 225, 229), would appear to answer satisfactorily the objection.

Tasmania and Bass Strait

Pulleine (1929, p. 296) refers to two groups of anthropologists, 'the overlanders and the voyagers', in discussing the Tasmanian migrations. The voyagers have been in two schools: (A) the advocates of an ocean voyage from Melanesia (Huxley, Wood Jones, Pulleine); (B) those who favour merely a voyage across Bass Strait from the mainland.

In Class A, the writer of this paper postulates a subsidiary group modifying the cross ocean voyage to a voyage in a series of arcs under the influence of prevailing winds and currents. In class B, a further subsidiary group is also proposed, in that all the data so far presented in this paper lead to the conclusion that if the crossing of Bass Strait could be achieved by the Tasmanian aboriginal, it must have been by a route other than those propounded in previous literature; further, that the likelihood of the direction being from Tasmania to Australia is greater than the likelihood of an Australia to Tasmania passage.

Geography and Previous Literature

Frequent reference occurs in the literature to 'the numerous islands of Bass Strait', but a precise enumeration or chart of these does not appear to occur in anthropological or anatomical writings. The total mass of data on Admiralty

charts 1695A and B, which together measure over four feet by three feet, prevents a layman obtaining a clear-cut impression of the land distribution in the Strait. No geographical atlas appears to present a plate of the Bass Strait area which faithfully reproduces all the islands, islets, rocks, and reefs. Errors occur either of omission or of inaccurate placement and dimension.

To overcome this difficulty a map (Plate XIII B) has been constructed direct from Admiralty Charts 1695A and B, drawn to scale as meticulously as possible. The map is mercator projection, the distance between degrees of latitude being 60 miles and between degrees of longitude 47½ miles. Submerged reefs have been omitted; also rocks submerged at high water. All other land surfaces are positioned. The map is bounded by 38° 50′ and 41° of southern latitude (representing 130 miles) and by 143° 20′ and 148° 40′ of eastern longitude (representing 253 miles). Within this area lie 126 islands or islets or rocks above high water level, including the north coast of Tasmania itself.

In the western chain the essential facts are:—

(1) Distance between Cape Otway and King Island—47 miles.
(2) Distance between King Island and Hunter Island—38 miles.
(3) Reid Rock is 12 miles from King Island, between King and Hunter Islands.
(4) Albatross is 6 miles from Hunter Island, between King and Hunter Islands.

Ten miles inland from Cape Otway is a peak 1650 feet high. The highest point of King Island, 700 feet, is at the southern end of the island. The intervening distance between these two peaks is 86 miles. From Tasmania to the 300 feet high northern end of Hunter Island there is continuous adjacent visibility, with intermediate steps available.

In the eastern chain the essential facts are:—

(1) Between Wilson Promontory and the N.E. corner of Tasmania there exist considerable land masses, the Hogan, Curtis and Kent Groups, Flinders, Cape Barren and Clarke Islands.
(2) Additional isolated islets appearing as specks on the map are actually of considerable height and dimension, namely Rodondo, Devil's Tower, Sugarloaf, Wright Rock, Craggy Island and Pyramid.

The question of whether all of these would afford a landing and subsequent food and water is open to discussion. Probably Devil's Tower, Sugar Loaf and Pyramid would present extreme difficulties. Some factual information is available. Pyramid, 20 miles south of the Kents and 24 miles west of Flinders, is 243 feet high, extremely precipitous, and no landing has ever been effected upon it to anyone's knowledge. Rodondo, 1150 feet high, lies about 8 miles due south of the Promontory, 5 miles west of West Moncoeur (318 feet high) and 6½ miles west of East Moncoeur (331 feet high) (see Plate XIV A). Although granitic in composition, the configuration of Rodondo expresses its constant subjection to prevailing westerly winds and easterly setting current; similar expression is offered by Cleft Island of the Anser Group (see Plate XIV B). Bechervaise with five others effected a landing on Rodondo and remained for eight days in January 1947. Significantly, the only suitable camp site was on the south-east side and mutton bird burrows were also found to honeycomb the eastern side of the cap, that is, sheltered from the prevailing elements. The island possessed no mammals—'not even rats or mice'—no snakes, and no water. Apparently this party was the first ever to set foot on Rodondo (Bechervaise, 1947).

No factual evidence appears to exist of pre-white aboriginal occupation or landings on the islands of the northern half of the eastern chain. It is probable that the National Geodetic Survey of Australia will in the near future provide factual data about these islands.

Measuring off the distances between adjacent islets in this eastern chain it is seen that there is progressive increase in intervening expanses of sea from Tasmania to Victoria. Twenty-eight miles (Kent to Curtis) is the longest span. In whatever order the islands are employed as stepping stones, a span of at least 20 miles must be covered at some stage. (The Hogans and East Moncoeur are 20 miles apart.) Differently planned routes would include a necessary passage of, for example, 25 miles (Hogans to Wilson Promontory).

Between chains.—The shortest distance between the western and eastern chains is a south-west to north-east line of 83 miles between Three Hummock Island and Cleft Island in the Anser Group.

Meston (1935) thoroughly considered eleven islands off the north-west corner of Tasmania. He not only checked the tides, currents, winds and geographical data, but personally investigated the region. In addition, he set out very fully the previous literature related to Tasmanian water craft and analysed the Tasmanian as a seaman. It is a valuable paper and the only one which to the writer's knowledge approaches the subject of Tasmanian migration using as data the actual physical conditions of the region. The writer's personal experience of this corner of the Strait is limited to visual inspection of Three Hummock, Robbins and Hunter Islands from Stanley and from the air.

When Meston departs from the Hunter Islands and considers the entire region, however, a few points are open to comment:—

(1) The entire Bass Strait region can be summarised as being subjected to conditions which would drive native craft to the north-east or east. The eastern or Bassian chain is not immune from this principle. Meston's reference to the mere 30 mile gap between Deal and Flinders Island (1936, p. 161), while correct as far as it goes, is incomplete. For example, native craft attempting to pass from the Hogans to East Moncoeur, or from Kent to Curtis, would have opposition from wind and current all the way. The reverse direction would seem distinctly possible and even easy. On the other hand, an attempt to pass between Flinders and Kent, and between Kent and the Hogans, in either direction, would appear to offer every likelihood of being carried into the Pacific.

(2) Although the eastern chain is more generously studded with islands than the western, adjacent islands of the eastern chain being visible one from another in perfect conditions, natives in rafts or canoes at sea level would be out of sight of land for some distance along a voyage between them. As Meston's paper indicates, tide races exist between Tasmania and those islands within 6 or 7 miles of it. Natives in many parts of the world make use of tides to carry them across such distances when employing merely logs or planks. But the opportunity to plan, let alone employ tidal assistance for a voyage in native craft over a distance of 20 or 30 miles involves a problem of deliberate and complicated navigation. It must be indicated again that the problem of whether lower sea levels in former time periods would modify these results is one which this paper has not attempted to investigate.

(3) Meston (1936, p. 161) says: 'The natives built to suit their purpose . . . when the occasion demanded, they built something really seaworthy'. ' . . . could remain afloat for a long time . . . could drive them along at a fast rate.' 'That they could make the extremely difficult crossing between the mainland and the Hunter Islands proves them expert and fearless seamen.' 'In the face of such seamanship . . . ' 'boats such as Freycinet described, could easily have managed such a voyage.'. In 1937 (p. 90), however, he says, 'But it is difficult to believe that the Tasmanians forgot how to construct the substantial seagoing canoe, yet remembered perfectly how to construct that type of canoe which their ancestors had made thousands of years before'.

(4) Of the islands proved to have been visited by the aborigines, none is separated from adjacent land by more than 11 miles and the average distance is 3 miles. The storm lashed description of the islands is exaggerated. The writer's photograph of Tasman Island (Plate XIV C) shows a pond-like sea surface and the writer's own experience, and the charts and records, show considerable periods of calm seas. It will be observed also that in the photographs of Rodondo and Cleft Island the sea is perfectly calm. The capacity to reach islands 3 or even 8 miles away against wind and current is not an indication that a similar performance could be made over 20 to 30 miles; there must be a limit to day and night paddling.

One other comment in the literature should be mentioned. Wunderly (1938*a*, p. 124) says 'The nearest island on each route is visible in clear weather from the Victorian Coast, the height of the ranges at Cape Otway providing the elevation necessary to bring King Island into view. By either route land is within sight throughout the whole journey from coast to coast when visibility is very good'. Again (1938*b*, p. 202) ' . . . King Island, which is close to the north-west corner of Tasmania, is visible from the ranges at Cape Otway on the Victorian Coast'. Wunderly gives no data to support the statement and makes no claim to personal experience of the region. Residents of Cape Otway have claimed to have seen lights on King Island on rare occasions of nights of perfect visibility.

The data place a 1650 feet high peak ten miles inland from Cape Otway and a 700 feet elevation occurs at the southern end of King Island. Distance between the two peaks is 86 miles. Distance between the two nearest land points of Otway and King Island is 47 miles. Using a rule of thumb method, which regards range of visibility as the square root of the elevation increased by one-third, King Island and Cape Otway are out of range at their sea fronts. By tables they are also out of range. By rule of thumb the two peaks 86 miles apart are also out of visual range. By tables visual range could not be established from the inland peak 10 miles behind Cape Otway even in exceptional conditions. Whittaker's Almanac (1947, p. 192) indicates that for 82 miles of visibility an elevation of 4000 feet is necessary.

The writer of this paper had the personal experience, during a twenty months deliberate observation period, of crossing a direct line between Cape Otway and King Island on 22 occasions (see Plate XIII A). The points on which the direct line was crossed varied from close to Cape Otway to a position equidistant between the two. A total of 38 days have been spent on the sea between the two; admittedly 23 of the 38 were bad weather days. On not one occasion was King

Island seen. From the mid-point on the line between Otway and King Island neither was in sight; and that was an occasion of good weather and visibility. In addition, sailing into Phoques Bay and Sea Elephant Bay at King Island from Apollo Bay, from Port Phillip and from Wilson Promontory, the island did not come into the range of visibility until the ship was within less than fifteen miles of the island.

It is the writer's opinion, based on these considerations, that King Island cannot be seen from Cape Otway and that an attempted voyage along the Otway-King Island-Hunter Island route would leave natives riding a canoe or raft at sea level well out of sight of land for a considerable time and distance, even allowing that the currents and wind permitted them to stay on their course. A further observation is worth recording. On the air route direct from Melbourne to Hobart, which crosses the Victorian Coast between Cape Schanck and Sandy Point, and the Tasmanian coast near the mouth of the Tamar, none of the islands of the eastern or western chains are visible from a height of 7000 feet. In addition, it has been the writer's experience that taking off from King Island on the air journey from King Island to Melbourne, Cape Otway is not visible from the air at an elevation of 1500 feet.

It should be pointed out that charts represent statistical results; an infrequent occurrence may be submerged in the dominant mass of data. However, in the Bass Strait region the data appear to be very definite. So much so that the following suggestions can be made:—

(1) A native craft deliberately or accidently leaving the Cape Otway region could return, or might be carried to any part of the south coast of Victoria.
(2) A craft half-way between Otway and King Island would be carried to the Port Phillip region.
(3) A craft leaving King Island would be carried to Wilson Promontory.
(4) A craft between King Island and the Hunter Group would be carried to the Kent, Curtis, or Hogan Groups.
(5) A craft between the Hunter Group and Flinders Island would be carried to Flinders or further north, although opposed by the flood tide from the east.
(6) A craft off the northern shores of Tasmania at, say, the Emu Bay region would be carried to Waterhouse Island.

These results could be negatived over short distances up to say six or seven miles. The effort of paddling longer distances day and night against prevailing winds and current would be too great. Harrisson, a good canoeist himself, pointed out that such conditions would barely be negatived, let alone overcome.

As a final conclusion, it would seem from the data that the only likely possibility of sea contact or migration between Australia and Tasmania would consist in two parts:—

(1) An intentional series of voyages from Tasmania through the islands of the Hunter Group and on to King Island.
(2) A chance happening of being carried from King Island to the Anser Group or Wilson Promontory.

As a modification, and as a still more remote possibility, a chance voyage might be made from Three Hummock Islands to the Anser Group or Wilson Promontory under the influence of south-westerly changes of the dominant westerly winds. A reverse voyage from southern Victoria to the north-west coast of Tasmania would appear on the data to be impossible.

Application

Writers almost unanimously agree that whatever the affinities of the Tasmanians may be, they are an extraordinarly uniform race; Hooton (1946, pp. 610-611) is an exception. It is also agreed that the Tasmanian is some sort of Negrito. By contrast, the Australians have been accused of alien mixture in every corner of the continent at various times, depending on the popular theory in vogue. Obviously an investigation of data that might prove a migration possible or impossible becomes as important as the investigation of the crania themselves.

Factual evidence about the Victorian aborigines is scanty. What there is indicates that their numerical strength was small, their numbers fewer towards Wilson Promontory and that their intrusion into the southern tip of Victoria appears to belong to comparatively recent times (Elkin—personal communication). Similarly, data collected by Meston and so far unpublished, indicate the Tasmanian population to have been smaller in number than the figures usually given (Meston—personal communication).

The Victorian aborigines, until recently, were those most frequently quoted as exhibiting Tasmanian elements. Should this be so it seems more reasonable to expect variation as a result of more recent intrusion than as the result of an ancient residual stratum. As Haldane (1948, p. 788) points out, 'A small tribe without any natural selection progresses half-way to complete homozygosis, i.e., loses half its heterozygosis in a number of generations about equal to the number of breeding members in it. Thus, a small tribe can become genetically homogeneous in a few thousand years.'.

It might be pertinent to indicate that Wagner (1937) defined a Queensland group with New Caledonian affinities, a Northern Territory group—both these differing from southern aborigines—and possibly a different group again in West Australia. Howells (1937) found a separate group in the north-west of North Australia. Turner (1908, p. 388) saw 'a possible amount of intermixture' in the southern parts of South and West Australia. Fenner (1939) found a three group division, (1) coastal Northern Territory, (2) greater part of Queensland, and (3) remainder of the continent. Topinard (1872) described a pygmoid people in the far west differing from the remainder of a uniform continent, which Birdsell (1947, p. 232) appears to have reversed by finding a Negrito group in the east, a Murrayian in the south, and a Carpentarian in the north.

In view of the variety of alien affinities from time to time claimed to exist in the Australian aborigines, it is very obvious that the disciplines of physical anthropology should be supplemented in our region by all the data available about migrations or contacts and the history of events both ancient and modern.

In the matter of a claim for curly-haired, short-statured people in Queensland, it would seem that two facts should be kept in mind:—

(1) *A possible wind and ocean current route could occur from the New Hebrides to Queensland as set out in this paper.*—In the New Hebrides, there is an extraordinary complexity of culture differentiation. Moreover, Speiser and Deacon refer to two main physical types and a further group of small stature folk (apart from the bush people, Naru Bugoi)—the Mavur or Maur or Mawughke, the so-called Pygmies of Malekula.

Among the specimens in the Anatomy Department of the University of Sydney there are a cast of a Negrito skull from the Andaman Islands and a skull from Malekula. The latter is one of nine skulls collected by Deacon from the Big Namba territory of Malekula.

Its appearance is quite different from its eight companions; it is found to be almost exactly identical, not only in appearance but even in measurements, with the Andaman skull. I am indebted to Professor Burkitt for directing my attention to the almost complete similarity of these two Negrito skulls (Plate XIV, D and E): one is from the Andamans, one is from Malekula; their appearances are identical; and the Tasmanian is classed by all as some form of Negrito.

(2) *The modern importation of New Hebrideans into Queensland.*—Fenner is one of the few writers who goes so far as to appreciate this imported labour as a possible modifier of the physical anthropology of the Australian. In mentioning (1939, p. 301) 'the gradation of the B factor from Melanesia to Southern Australia', he suggests a considerable Melanesian infiltration and quotes Cleland (1930) as deciding that the B factor introductions are all quite recent. The writer has not succeeded in finding any comprehensive data on the blood groups of the Atherton Tableland aborigines.

It is very necessary that some idea of the actual statistics of the New Hebridean introduction into Australia in the 19th century should be realised fully. In 1847 Benjamin Robert Boyd brought 65 New Hebrideans to Riverina sheep stations to act as shepherds; they are said to have died quickly (Harrisson, 1937, p. 187). Between 1867 and 1901, 46,000 to 47,000 were brought into Australia. Of these, between 1868 and 1876, 11,206, including 247 women, were brought into Queensland, and only 4129, including 61 women, were returned. 'Some natives stayed on after Federation and are living and slowly increasing as permanent settlers in Queensland'. In 1901, 751 were known to have been born in Australia and also 181 half-castes.

Professor Burkitt has drawn my attention to the fact that in Malekula four distinct head forms exist: (1) Melanesian, (2) Negrito, (3) Australoid, and (4) Cranial Deformation. A plate in Deacon's book, reproduced also in Harrisson's book, shows a group of natives (mountain folk of Santo), the caption reading 'the first man is a chief and he looks quite Australoid. The second is noticeably Pygmoid'.

The picture is therefore complex:—

(1) A negrito people exists in Malekula, Santo and Omba in the New Hebrides.

(2) A sea route is possible between New Hebrides and the east Australian coast and Tasmania.

(3) Deacon (1934, p. 121) indicates rafts not very unlike the general dimensions and pattern of that on Maria Island described by Lt. Jeffries and pictured by Crowther (1934).

(4) Of 47,000 New Hebrideans introduced in the 19th century into Queensland not more than one-third returned home.

(5) In the 1939 census the 'full blood' Australian aborigines were given as 12,030 for Queensland and the half-castes 6788.

(6) A Tasmanoid and an Australoid people (in appearance) both exist to-day in Malekula.

What test can be applied to Queensland aborigines to differentiate progeny of ancient Negrito mixture from progeny of modern Negrito mixture? Are they Tasmanoid or Malekulan Negritos? Have Tasmanoids and Malekulan Negritos a very close affinitity? Could a long, arduous and painstaking genealogical study hope to unravel the situation at this stage? Meston's (1947, pp. 47-52) genealogical

examination of the Furneaux Islanders indicates how complex the problem can be. Among these islanders, usually referred to as half-castes and by inference Tasmanian half-castes, he has discovered ancestors including a Negress, a Hindoo woman, a Jew, Australian as well as Tasmanian aborigines, a variety of white nationals, possibly also Maoris and the existence of wives, if not off-spring, who were Tahitians. These problems are further complicated by such statements as those of Muller and Little (1947) that 'such racial differences as are due to genes come about largely as a result of variations in the frequencies of alleles from race to race. Such inter-racial variations are often less significant than the variations within a single race.'.

Summary

Many migration theories ignore the opposition of prevailing ocean currents and winds. Examples are quoted to show that in the vast majority of recorded cases these are the major factors.

The inability of native craft to beat to windward applies also to Polynesians and Malays and, until the 17th century, to Europeans also.

Following some remarks on the history of charts and the examination of winds and currents around Australia, citing particularly Halligan (1921) and David (1932), modern Admiralty charts of currents and winds are examined in some detail.

The writer briefly mentions his *personal experience* of 140 days in Bass Strait, covering 10,000 miles at an average of 3 miles an hour over the ground, day and night steaming, in a period of 20 months. Bad weather occurred in only 20 per cent of the time, distributed fairly evenly over the 20 months.

Possibilities allowed by prevailing currents and winds seem to be:—

(1) The north-western part of Australia is exposed to alien contact from N.N.W. and E. and is probably linked with Celebes and Indonesia and the islands of Torres Strait, New Guinea and possibly Melanesia.

(2) The west coast of Tasmania is subject to the slender possibility of contact from W. Australia, but heavy seas probably preclude this.

(3) From the New Hebrides to Tasmania a curvilinear voyage to the N.W., then the S.W., then S., then S.E., then S.W., is theoretically possible under the influence of current and wind in the months of November, December and January. The journey might require 50 to 80 days to cover about 2600 miles. Examples have been quoted to show that such a voyage has often been surpassed. A direct route of 1700 miles from New Caledonia to Tasmania is probably impossible.

(4) An alternative arc voyage to the Queensland coast from the New Hebrides also appears possible.

(5) In Bass Strait prevailing conditions represent a push to the north-east or east. Geography and previous literature on this region are discussed. It appears that for native contact between Australia and Tasmania across Bass Strait the only likely possibility would be an intentional voyage from the N.W. corner of Tasmania as far as King Island, followed by an involuntary one from King Island to Wilson Promontory.

(6) The Tasmanian craft are shown from the literature to be more varied and more capable of seaworthiness than is generally supposed. Peruvian and New Hebridean type of raft construction may be significant.

Food, water, time and distance do not appear to determine successful voyages, but rather the prevailing winds and currents and the absence of storms and heavy seas, to which native craft have little resistance.

Application of the subject to Anatomy and Anthropology.

Most people regard the Tasmanians as uniform. Two schools regard the Australians as (*a*) a uniform, (*b*) a mixed people.

Theories of where the alien influence occurs and what it represents have been diverse. The importation into Queensland between 1847 and 1901 of four times as many New Hebrideans as there are full blood Australian aborigines in Queensland (census 1939) complicates the picture, particularly as Negrito people exist in Malekula, Santo and Omba.

Until the discipline of genetics becomes more advanced the writer suggests that our knowledge of skull form in mixed peoples is so meagre as to make surveys of other data very necessary as an auxiliary to physical anthropology and as a test of whether the conclusions of the latter are possible.

No definite conclusions are reached. This paper is a survey of what appears possible and of what does not appear possible. Further, it represents the bare outline of a more extensive treatment of the subject, not yet completed.

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